AMBIENT AIR QUALITY IN WINDSOR

1972 to 1976

Ontario
Ministry of the Environment

AMBIENT AIR QUALITY

IN

WINDSOR

1972 TO 1976

Technical Support Section
Southwestern Region
ONTARIO MINISTRY OF THE ENVIRONMENT

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SUMMARY

With the exception of oxidants, nitrogen oxides and hydrocarbons there has been a trend of improving air quality in the Windsor area since 1972. This is reflected in the decreasing annual average concentration of pollutants and the decreasing percentage of occurrences of pollutant concentrations above the desirable ambient air quality criteria.

Oxidants, which are measured as ozone, were higher during 1976 than previous years. The 1976 increase in ozone was noted throughout southern Ontario and much of North America. The levels reached caused vegetation damage and were capable of causing adverse health effects. It should be noted that there have been no documented health effects attributed to ozone in Ontario. Since oxidants are formed by a series of complex atmospheric reactions involving hydrocarbons and nitrogen oxides and since oxidants and their precursor chemicals are capable of travelling great distances and therefore affecting remote areas, it is essential that control strategies currently being considered in Ontario are compatible with those strategies being developed in those areas of the United States that are capable of significantly contributing to oxidant levels in Ontario.

The Air Pollution Index levels reported for 1976 were indicative of satisfactory conditions in terms of potential health effects associated with the combination of sulphur dioxide and particulate matter.

From a nuisance standpoint, particulate matter, measured as suspended particulate and dustfall, was excessive in southwest Windsor and the downtown area of Windsor. Because of the many sources of large amounts of particulates located in Wayne County, Michigan, as compared to the number of similar sources in Windsor, the achievement of satisfactory levels of particulate matter will depend greatly on current and future pollution abatement programs in Wayne County. There is a localized area of high levels of particulates in the vicinity of the Windsor Casting Plant of Ford Motor Company of Canada, Limited, that should be greatly improved in 1979 when further pollution abatement measures at that Company are fully implemented.

Ontario Hydro's J. C. Keith generating station was the principal source of sulphur dioxide in Windsor. In the spring of 1976 this generating station ceased operations and will not be re-commissioned without extensive air pollution abatement facilities being incorporated. Therefore, with improvements in the control of sulphur dioxide emissions at nearby Wayne County sources also anticipated, acceptable levels of sulphur dioxide should be achieved barring any increase in sulphur dioxide emissions due to new or expanded sources.

Carbon monoxide concentrations measured in downtown Windsor met the desirable ambient air criteria continuously during 1976 and the annual average concentration was the lowest recorded since monitoring began in 1969.

Fluoridation rates, which are measured to detect fluoride levels potentially capable of causing vegetation damage, were excessive in the vicinity of Morton Dock. However, annual phytotoxicology studies have not detected more than trace vegetation damage.

INTRODUCTION

The ambient air quality monitoring network operated in Windsor by the Ministry of the Environment is designed to measure a number of pollutants which may be directly or indirectly harmful to health, vegetation or property and to provide an indication of the point and area sources of these pollutants. Most of the monitoring equipment is located in areas of poorer air quality such as those close to heavily industrialized and commercial areas. When the air quality is acceptable in these areas then the residential and rural areas are normally found to have satisfactory air quality.

Some pollutants such as sulphur dioxide and suspended particulates are measured at several locations in Windsor while others such as carbon monoxide and oxides of nitrogen are measured only at the main monitoring station located near the downtown area.

The Air Pollution Index is determined at two stations in Windsor utilizing continuous sulphur dioxide and soiling measurements. Meteorological data produced at another station in Windsor are utilized in forecasting the persistency of adverse weather conditions. The API enables quick corrective action to be taken and therefore minimizes short-term adverse health effects due to elevated levels of sulphur dioxide and particulate matter.

As well as presenting the 1976 ambient air quality data, this report presents a summary of the data collected since 1972. Data collected since the beginning of 1972 are sufficiently abundant to permit a meaningfull comparison and trend analyses.

MONITORING NETWORK DESCRIPTION

This Ministry's monitoring network in Windsor consists of an array of continuously and intermittently operating monitors dispersed throughout the Windsor area. The monitoring is more intensive in the downtown commercial area and the area of southwest Windsor which is close to a heavily industrialized portion of Wayne County, Michigan and is where Ontario Hydro's J. C. Keith Generating Station is located.

The locations of the monitoring stations are illustrated in Figure A of Appendix I and the specific locations and an indication of their elevations are provided in Table A of the same Appendix. The various pollutants measured are shown in Table B and the Ministry's desirable ambient air quality criteria for these pollutants and the prime bases for these criteria are contained in Table C (Appendix I).

In addition to monitoring by the Ministry of the Environment, monitoring of ambient air quality in the Windsor area is conducted by Ontario Hydro and Environment Canada. However, data obtained by these two agencies are not included in this report.

METEOROLOGICAL DATA

Meteorological data are collected from Ministry stations 12032 and 12034 (see Figure A of Appendix I). At station 12032 wind speed and direction are measured at levels of 7 metres and 30 metres above ground.

Station 12034 is used for the meteorological forecasting associated with the Air Pollution Index. It measures wind speed and direction at the 10-metre and 46-metre levels (above ground) as well as the ambient temperature at the 10-metre level and the difference in temperature between the 10-metre and 46-metre levels.

The percentage of time the wind was recorded to be blowing from various directions at the 30-metre level of station 12032 appears in Table D (Appendix II). When the wind originates out of the north, northwest, west, or southwest it is possible for it to carry pollutants from Wayne County, Michigan into Windsor. During 1976 the cumulative frequency of winds from these directions was 61.2 percent which is greater than the cumulative frequencies of 53.0, 58.4, 51.6 and 54.1 percent recorded during 1972, 1973, 1974 and 1975 respectively.

AIR POLLUTION INDEX

The Air Pollution Index (API) is recorded at two locations in Windsor, station 12008 in downtown Windsor and station 12016 in southwest Windsor. The API is calculated

by substituting continuous measurements of sulphur dioxide and soiling index into an empirically developed equation. Soiling index is a measurement of suspended particulate matter.

The sulphur dioxide and soiling index measurements are telemetered directly to a computer in a Ministry office in Toronto where the actual mathematical calculations are conducted. When the API is less than 32 conditions are considered acceptable. API values between 32 and 50 are at the Advisory Level and if meteorological conditions are forecasted to remain adverse then operators of significant sources of pollution may be advised to prepare to curtail operations. API values between 50 and 75 are at the "First Alert" Level and operators of major pollution sources may be ordered to curtail operations. Values between 75 and 100 and values greater than 100 necessitate greater cut backs in pollution emissions as the index increases.

During the past few years the Advisory Level of 32 has occasionally been approached in Windsor. However, persistently unacceptable conditions have not been experienced.

PARTICULATES

Air borne particulates originate from a vast number of sources. Some of the more important sources in the Windsor-Detroit area are the combustion of fossil fuels, the iron and steel industry, foundry operations, road traffic and wind erosion of soil. The re-entrainment into the air of particulates which have settled on smooth surfaces such as buildings, roadways, and parking lots can be a very significant source.

Particulates in the ambient air of Windsor are measured as dustfall, suspended particulates, and soiling index. Dustfall is measured by collecting free-falling particles in open-mouth jars. Suspended particulates are determined by drawing measured volumes of ambient air through filter paper and then calculating the mass of particulates trapped on the filter paper. The soiling index of particles is determined by recording the difference in light transmittance through filter paper before and after a specified volume of ambient air is drawn through the paper. Soiling index is expressed as co-efficient of haze (COH).

Dustfall and suspended particulates are direct measurements of the mass of the particulates collected. Soiling index can only be empirically related to the suspended particulate measurement. This is because the transmittance of light is dependent on the size and shape as well as the mass of the particles entrapped on the filter paper. Unlike dustfall and suspended particulate measurements, which involve laboratory procedures and are therefore not immediately ascertainable, the soiling index can be calculated continuously in the field. The continuous recording feature is the reason for the soiling index being used in the Air Pollution Index.

Dustfall -

The monthly desirable ambient air criterion for dustfall is 20 tons per square mile per 30 days and the annual average criterion is 13 tons per square mile per 30 days. These criteria have been developed from historical data and criteria established by other enforcement agencies. The annual average criterion was exceeded at 20 of the 21 sites monitoring dustfall in Windsor. The annual average dustfall concentrations and the percentage of monthly dustfall concentrations above the criterion are highest in downtown Windsor and southwest Windsor, the latter being close to a heavily industrialized area of Detroit. The 1976 dustfall data are included in Table E, Appendix III.

The trend since 1972 has been a general decrease in the annual average dustfall concentration and the percentage of occurrences of dustfall concentrations above the monthly desirable ambient air criterion. Notwithstanding this downward trend, the achievement of desirable air quality from the standpoint of dustfall levels cannot be anticipated in the near future. The trend data are included in Figure B and Table F of Appendix III.

Suspended Particulates -

The suspended particulate criteria are 120 micrograms per cubic meter (ug per m^3) of air during 24 hours and an annual geometric mean of 60 ug per m^3. The 24-hour criterion is based on the impairment of visibility and adverse health effects associated with combined concentrations of sulphur dioxide and suspended particulates. The annual criterion is based on damage to property.

The suspended particulate network consists of ten monitoring sites located adjacent to the Detroit River. During 1976 only the two stations located in northeast Windsor at the head of the river met the annual criterion. These two stations very seldom exceed the 24-hour criterion and normally only under adverse meteorological conditions. For those stations situated in downtown and southwest Windsor the annual criterion was exceeded in 1976 by a wide margin and the percentage of values above the 24-hour criterion ranged from 11 to 42 per cent.

From 1972 through 1975 there was a very appreciable downward trend in the annual geometric mean and the percentage of suspended particulate concentrations above the 24-hour criterion. There was an increase in these values during 1976 but they remained well below the values obtained prior to 1975. In 1976 there was also a greater frequency of winds from Wayne County, Michigan, where the major man-made emissions of suspended particulate originate, and this may be the reason for the increases in 1976 over 1975. Trend data from 1972 through 1976 appear in Figure C and Table G, Appendix III.

During 1976, 37 per cent of the suspended particulate concentrations at monitoring station 12013 were above the 24-hour criterion. This station had an annual geometric mean concentration of 98 ug per m^3, which was the second highest value for the 12 stations at which suspended particulates were monitored, substantially exceeding the annual criterion. Exceptionally high concentrations of suspended particulates were determined occasionally at station 12013 during periods when the other Windsor stations had relatively low particulate concentrations. This localized suspended particulate condition, as well as higher-than-anticipated dustfall concentrations at stations 12013 and 12022, are in part a reflection of particulate emissions from the Windsor Casting Plant of Ford Motor Company Canada, Limited. Pollution abatement action planned for the casting plant should reduce the concentrations of particulates in this area.

Soiling Index -

The desirable soiling index criteria for ambient air are 1.0 COH averaged over the 24 hour period of midnight to midnight and an annual average of 0.5 COH. These criteria are associated with health effects due to the combined

reaction of particulates and sulphur dioxide. There are eight stations monitoring soiling index in Windsor, all of which are located close to the Detroit River. The annual average soiling index criterion was met at all stations, which has been the case since 1972. The soiling index data appear in Figure D and Table H, Appendix III.

The 24-hour soiling index criterion was met continuously at three of the eight stations throughout 1976. This criterion was not met 0.7 to 1.7 percent of the monitoring time at three of the four stations located in southwest Windsor, one of the two stations located in downtown Windsor, and station 12013 which is located in the immediate vicinity of the Windsor Casting Plant of Ford Motor Company Canada, Limited. The station in downtown Windsor, which met the 24-hour criterion continuously, is situated on a roof top 50 feet from ground level and consequently its data are not representative of the concentrations normally encountered at ground level.

Since 1972, the annual average soiling index values have tended to remain relatively consistent and within the criterion. However, there are some stations which have exhibited a downward trend and there has been a general decrease in the percentage of values above the 24-hour criterion. Notwithstanding this general improvement since 1972, the annual average COH values and the percentage of COH values above the 24-hour criterion as measured at stations located in southwest and downtown Windsor were slightly greater in 1976 than in 1975. This may be attributable to the increase in the percentage of winds from the direction of major particulate emissions in Wayne County, Michigan.

SULPHUR OXIDES

The combustion of fuels containing sulphur and the subsequent emission of sulphur oxides in flue gases are the predominant source of sulphur oxides in the atmosphere. The availability of low sulphur fuels and man's capability of removing sulphur from fuels and sulphur oxides from flue gases will be very critical to the future control of ambient sulphur oxide levels.

In Windsor, sulphur oxides are measured directly or indirectly by three different techniques. Continuous measurements of sulphur dioxide gas and intermittent analysis of suspended particulates for sulphate content are the direct methods. The indirect method involves the measurement of sulphation rate by exposing 100 square centimetres (cm^2) of lead peroxide filter paper for approximately one month and subsequent laboratory analysis of the amount of sulphur trioxide which has formed due to the reaction of sulphur dioxide with the filter paper. A minor portion of the sulphation rate number is due to oxidizable sulphur compounds other than sulphur dioxide such as hydrogen sulphide reacting with the lead peroxide to form lead sulphate.

Sulphur Dioxide Gas -

This Ministry monitors sulphur dioxide continuously at five separate locations in Windsor. The data are reported as one-hour concentrations, 24-hour average concentrations calculated on a daily midnight to midnight basis, and annual average concentrations. The desirable ambient air criteria are 0.25 ppm during 1-hour, 0.10 ppm during 24-hours, and an annual average of 0.02 ppm.

In late 1976 a sulphur dioxide monitor was placed in operation at station 12013, located in north Windsor. There is an insufficient amount of valid data from this station available for discussion. Besides station 12013 there are three stations monitoring sulphur dioxide in southwest Windsor and one in downtown Windsor. Excursions above the hourly and the 24-hour desirable ambient air criteria occurred at the downtown station and at two of the southwest stations only when the wind was from the general direction of both the Ontario Hydro generating station and the industrialized area of Wayne County. No excursions occurred at any of these three stations after the Ontario Hydro generating station shut down in May, 1976.

The other station continuously monitoring sulphur dioxide in southwest Windsor (station 12032) experienced only two excursions above the hourly criterion and these excursions occurred when the Ontario Hydro generating station was shut down and the wind was from the industrialized area of Detroit. There were no excursions above the 24-hour criterion at this station.

Station 12015, located in southwest Windsor at the West Windsor Water Pollution Control Plant, was brought on-line in 1974 to confirm the occurrence of downdrafting of the plumes from the Ontario Hydro J. C. Keith generating station stacks and to evaluate the effect on ambient air quality. The excursion values in January and February 1976, that are tabulated in Table I, Appendix IV, along with other sulphur dioxide excursion data, illustrate that downdrafting creates very high sulphur dioxide concentrations, but subsequent shutdown of the J. C. Keith generating station resolved this problem. Before the station is re-commissioned as envisaged, pollution abatement measures will be necessary to ensure minimal effect on ambient air quality.

In addition to the shutdown of the J. C. Keith generating station in 1976, a small boiler adjacent to station 12008 in downtown Windsor was converted from oil to natural gas fuel. Since the boiler stack is close to the monitoring intake and natural gas has appreciably less sulphur than oil, the switch-over in fuel may decrease the levels of sulphur oxide recorded at station 12008.

The annual criterion of 0.02 ppm sulphur dioxide was exceeded only at station 12008 where the annual average was 0.03 ppm.

A review of the trend in sulphur dioxide concentrations for Windsor from 1972 through 1976 reveals a general decrease in the percentage of values above the 1-hour and 24-hour criteria. The trend data are illustrated in Table J, Appendix IV.

Sulphation Rate -

During 1976, sulphation rates were measured at 22 different locations in the Windsor area. This large array of monitoring locations provides an excellent means of determining comparative ambient air quality for sulphur oxides in various sections of Windsor as well as the general trend in sulphur oxide levels. The desirable ambient air criterion for sulphation rate is 0.70 milligrams (mg.) of sulphur trioxide per 100 cm^2 of exposed lead peroxide per day. This criterion, under normal circumstances, is considered to be compatible with the annual sulphur dioxide average, for which an ambient air criterion based on vegetation damage has been established.

From the 1976 monthly sulphation rates in Table K, Appendix V and from the annual average sulphation rates and the frequency of excursions over the desirable ambient air criterion as depicted by Figure E and Table L, Appendix IV, it is apparent that:

1. Only those stations located in the downtown commercial area of Windsor and the southwest area, which contains the Ontario Hydro J. C. Keith Generating Station and is close to heavy industry and power generating stations in Wayne County, Michigan, had greater than a 10 percent frequency of excursion above the criterion in 1976.

2. The annual average sulphation rate and the overall frequency of excursions above the sulphation rate criterion was greater in 1976 than in 1975 or 1974. However, the 1976 average and frequency of excursions remained well below the corresponding 1972 and 1973 values.

Sulphates -

Ontario currently has no desirable ambient air criteria for the sulphate content of suspended particulates. Sulphate content in suspended particulates has been analyzed on an intermittent basis in the Windsor area since 1969. During 1976, a more intensive sulphate analysis program was launched and essentially all suspended particulate filters collected at five stations in Windsor were analyzed for sulphates. Table M, Appendix IV, contains the average sulphate concentration for these five stations.

The average sulphate content in the suspended particulates was 11 per cent for four of the stations. The fifth station, 12013, reported only a 7 percent sulphate content. This lower percentage of sulphate can be partially attributed to a higher-than-normal suspended particulate concentration due to a nearby emission source which would contribute non-sulphate suspended particulates.

Comparatively, an 11 percent average sulphate content in suspended particulates was determined for downtown London and in the Sarnia area the average sulphate content ranged from 13 to 16 percent. Therefore, the percentage of sulphates in suspended particulate for the Windsor area would appear to be typical of those in other metropolitan areas of southwestern Ontario.

CARBON MONOXIDE

The predominant man-made source of carbon monoxide is the combustion of fuels which oxidizes carbon to carbon monoxide. The motor vehicle is the combustion source that contributes the greatest amount of carbon monoxide.

Carbon monoxide is measured continuously at one location in Windsor, station 12008. The desirable ambient air criteria are 30 ppm during 1 hour and 13 ppm during any eight-hour period. Neither criterion was exceeded during 1976. The annual average carbon monoxide concentration for 1976 was 4 ppm, which was the lowest annual average ever recorded in Windsor.

A summary of the annual average concentrations since 1972 and percentage of results greater than the criteria is included in Table N, Appendix V.

NITROGEN OXIDES

The major source of nitrogen oxides is the combustion of fuel which oxidizes nitrogen to oxides of nitrogen. Vehicle exhausts and fossil-fuelled power plants are the prime contributors.

Nitrogen dioxide, nitric oxide, and nitrogen oxides are measured continuously at station 12008, located in the downtown Windsor area. The nitrogen dioxide concentration plus the nitric oxide concentration is equal to the nitrogen oxides concentration. There are no desirable ambient air criteria for either nitric oxide or nitrogen oxides. The criteria for nitrogen dioxide, which are 0.02 ppm during a 1-hour period and 0.01 ppm during the 24-hour period of midnight to midnight, have not been exceeded during the past five years. These criteria are based on odour threshold and health effects. Table N, Appendix V, contains the annual average concentrations of the nitrogen oxide compounds.

Although the ambient air criteria for nitrogen dioxide are not exceeded, the ambient air concentrations of nitrogen oxides contribute to the formation of photochemical oxidants such as ozone. Photochemical oxidants cause vegetation damage in southern Ontario and during 1976 ozone

concentrations throughout Southern Ontario approached levels capable of creating adverse health effects such as a reduction in the efficiency of physical performance. There has been no documentation of adverse health effects attributed to ozone in Ontario. The role of nitrogen oxide compounds in the formation of ozone is explained more completely in the section on oxidants.

HYDROCARBONS

Natural phenomena produce many hydrocarbons. The most abundant hydrocarbon present in ambient air is methane which is produced in substantial amounts by natural processes. Man-made sources of hydrocarbons are vehicle exhausts, evaporation of stored hydrocarbons such as gasoline, and incomplete combustion of hydrocarbon fuels.

Total hydrocarbons are monitored continuously at station 12008 in downtown Windsor. There are no desirable ambient air criteria for total hydrocarbons since there are a great number of hydrocarbons which exist in the ambient air and which exhibit different effects and characteristics. Hydrocarbons with known potential to cause specific detrimental effects are subject to legislation controlling the emission of such hydrocarbons.

Much research is being conducted into the control of the non-methane (or reactive) hydrocarbons as a means of reducing the production of photochemical oxidants. The formation of photochemical oxidants is discussed in the section on oxidants.

A summary of the total hydrocarbon data collected at station 12008, appears in Table N, Appendix V.

OXIDANTS

The photochemical formation of oxidants involves a series of complex reactions, many of which produce the necessary reactants for additional reactions. The prime reactants are the pollutants nitrogen dioxide, nitric oxide, and reactive hydrocarbons. The major man-made sources of these pollutants are fuel combustion and therefore power plants and motor vehicles are prominent contributors.

In respect to ambient air quality, the most important oxidants are ozone and peroxyacetyl nitrate (PAN). Ozone normally accounts for 80 to 95 percent of the oxidants present in ambient air.

When there is sufficient sunlight energy, nitrogen dioxide is reduced to nitric oxide and an oxygen atom. The oxygen atom is capable of reacting with oxygen gas to produce ozone. Nitric oxide through a series of chain reactions with hydrocarbons produces more nitrogen dioxide which can then be broken down photochemically resulting in additional ozone. Nitric oxide also reacts with ozone to produce nitrogen dioxide and oxygen and therefore, a reduction in ozone concentration.

Much evidence has been produced to prove that the presence of high ozone levels in many areas is for the most part due to the long-range transport of ozone and its precursors. On the basis of this evidence, as well as a detailed examination of the ozone data for Windsor, it is reasonable to conclude that a portion of the ozone measured in Windsor was formed by reactions involving nitric oxide, nitrogen dioxide, and reactive hydrocarbons emitted in other urban centres.

The precursors of ozone are also formed in nature. For example, nitrogen oxides are produced by soils and reactive hydrocarbons by trees. Ozone produced by reactions between the naturally formed precursor chemicals can approach the ambient air criterion. Also, convection currents may occasionally bring ozone down from the ozone layer surrounding the earth in the outer stratosphere. Lightning is another natural phenomenon which forms a minor amount of ozone.

There are 1-hour desirable ambient air criteria for total oxidants and ozone of 100 ppb and 80 ppb respectively. These criteria are based on vegetation damage and the protection of human health. No criteria have been developed for PAN.

In Windsor, total oxidants were measured continuously from 1969 through 1973 at Station 12008. At this same downtown location ozone has been measured continuously since the beginning of 1974.

During 1976 there was a much greater frequency of ozone concentrations above the desirable ambient air criterion than had been experienced previously by either total oxidants or ozone. This condition was true for most areas being monitored in Ontario and initial reports indicate that this was also true for much of North America. The 1972 through 1976 annual average concentrations and the percentage of concentrations recorded above the 1-hour ambient air criteria for total oxidants and ozone appear in Table N, Appendix V.

Besides the continuous ozone monitoring, the Phytotoxicology Section of the Ministry of the Environment conducts annual investigations for oxidant damage to vegetation in southern Ontario. Although the percentage of high ozone concentrations was much greater in 1976 there was not a proportional increase in vegetation damage. It must be recognized that ozone damage to vegetation is dependent on many factors such as type and age of vegetation, soil conditions, and meteorological conditions. Although the criterion (based on the protection of human health as well as vegetation) was exceeded throughout Southern Ontario, there has been no documentation of adverse health effects attributed to ozone in Ontario. The literature reports the symptoms created by elevated ozone levels as irritation to the eyes, nausea, and a decrease in physical performance such as in athletic competition.

A plot of the average hourly concentrations of nitric oxide, nitrogen dioxide, hydrocarbons, and ozone determined in Windsor for the month of August 1976 is illustrated by Figure E, Appendix V. The increase in vehicle traffic during the early morning rush hours is reflected by a increase in nitric oxide, nitrogen dioxide, and hydrocarbons. The nitrogen dioxide concentration continues to increase for a longer period of time than the nitric oxide or the hydrocarbons and the ozone concentration decreases during the rush hours because the nitric oxide and ozone react to form nitrogen dioxide. The formation of ozone and the decrease in nitric oxide, nitrogen dioxide, and hydrocarbons during the warmer and sunnier hours when photochemical reactions proliferate are exemplified in the plotting. Later in the day, as the energy received from the sun wanes, the photochemical reactions decrease and the ozone concentration decreases. Nitric oxide may still be oxidized by ozone to produce nitrogen dioxide but the photochemical reactions between nitric oxides and reactive hydrocarbons gradually terminate.

Control strategies being considered for ozone focus on the control of nitrogen dioxide or reactive hydrocarbon emissions or simultaneous control of emissions of both these pollutants. The long-range transport of ozone and its precursors makes it necessary to adopt a control strategy compatible to a large international area.

FLUORIDATION RATE

The major sources of fluorides in the Windsor ambient air are the steel industry located in the environs of Detroit, coal burned by power generating stations in Windsor and Detroit, the unloading of fluorspar from ships onto trucks in southwest Windsor and the subsequent trucking of the fluorspar to a plant outside the immediate Windsor area.

Fluoridation rate is measured intermittently by exposing limed filter papers for thirty-day periods. After exposure to ambient air for 30 days, 100 cm^2 of filter paper is analyzed at the Ministry's central laboratory to determine the amount of fluoride which has reacted with the lime. A fluoridation rate of 50 for example, is interpreted as 50 micrograms (ug) of fluorides which reacted with 100 cm^2 of limed filter paper during a 30-day period.

The two desirable ambient air criteria that have been established are based on vegetation damage. Consequently, the fluoridation rate criterion of 40 for the period of April 15 to October 15, representing the growing season, is more stringent than the fluoridation rate criterion of 80 for the more dormant period of October 16 to April 14. Since the months of April and October are included in both criteria but only one fluoridation rate per station is available for any single month, the fluoridation rates for April and October have been compared to the average of the two criteria (60 ug per 100 cm^2 per 30 days).

The eight stations that monitor fluoridation rate in Windsor are concentrated in the downtown commercial area and the southwest area of Windsor close to a highly industrialized section of Wayne County, Michigan. During 1976 all stations, except station 12027 which is located in the central area of Windsor, had at least one fluoridation rate value above the criterion as illustrated in Table O, Appendix

VI. However, only stations 12032 and 12035, both located in southwest Windsor, recorded excursions indicating a need for further investigation and possible corrective action. Phytotoxicology investigations have been conducted in this area since 1971 with no more than trace fluoride damage to vegetation being detected.

A review of the general trend in fluoridation rates from 1972 through 1976 indicates a slight downward trend in the average fluoridation rate and a very noticeable decrease in the frequency of excursions above the criteria. However, station 12032, located at Morton Dock, does not exhibit the downward trend in fluoridation rate and had the greatest frequency of excursions above the criteria in 1976. The data on trends are contained Figure G and Table P of Appendix VI.

CONCLUSIONS AND RECOMMENDATIONS

With the exception of photochemical oxidants, nitrogen oxides and total hydrocarbons there has been a decrease in the concentration of pollutants measured in the ambient air of Windsor during the five-year period from 1972 to 1976. The decrease has been accompanied by a similar decrease in the frequency of excursions above various desirable ambient air criteria.

Photochemical oxidants, which are measured as ozone, have increased throughout southern Ontario and much of North America. Because of the long-range transport of photochemical oxidants and their precursor chemicals it is necessary that control strategies being developed in Ontario to reduce oxidant levels be compatible with strategies being developed for the north central area of the United States. Photochemical oxidants detrimentally affect vegetation, materials and human health at very low concentrations and a high priority is therefore placed on reversing the upward trend in concentrations measured in ambient air.

Although the decrease in particulate matter has been very significant since 1972, particulate concentrations, measured as dustfall and suspended particulate, remain excessively high in southwest and downtown Windsor as well as in the immediate vicinity of the Windsor Casting Plant of Ford Motor Company of Canada, Limited. Abatement measures to control the emissions of particulates are scheduled for the casting plant. Emissions from sources in Wayne County, Michigan will have to be reduced significantly in order for satisfactory levels of particulates to be approached in Windsor.

Sulphur oxides are measured as sulphur dioxide gas, sulphation rate, and sulphates contained in particulates. The decrease in sulphur dioxide levels is expected to continue and only marginal and very infrequent excursions of the ambient air criteria are anticipated in the future. During 1976 the J. C. Keith generating station of Ontario Hydro ceased operations. This generating station was by far the most significant source of sulphur dioxide in Windsor and extensive measures will be taken to satisfactorily control emissions before the station is re-commissioned in the 1980's.

With the exception of the Morton Dock area in Windsor, fluoridation rates were quite acceptable during 1976. In the Morton Dock area the 30-day ambient air criteria were not met at any time. However, only trace vegetation damage due to fluorides has been detected in the annual phytotoxicology surveys conducted by the Ministry in the area.

Carbon monoxide concentrations determined during 1976 were (on average) the lowest experienced during the entire history of air monitoring in the Windsor area. Neither the 1-hour nor the 8-hour criterion were exceeded. Nitrogen dioxide concentrations remained similar to previous years with no excursions above the 1-hour or 24-hour criteria.

Because of the density of major industry located in Wayne County, Michigan close to southwest Windsor and the current high levels of particulates being measured in this area of Windsor, it is recommended that future residential development in Windsor be planned and located to minimize the effects of air pollution on property and people.

The monitoring network requires revision to provide better information on the distribution of particulate matter throughout Windsor. This will be accomplished by locating additional suspended particulate samplers during 1977.

A P P E N D I X I

MONITORING NETWORK

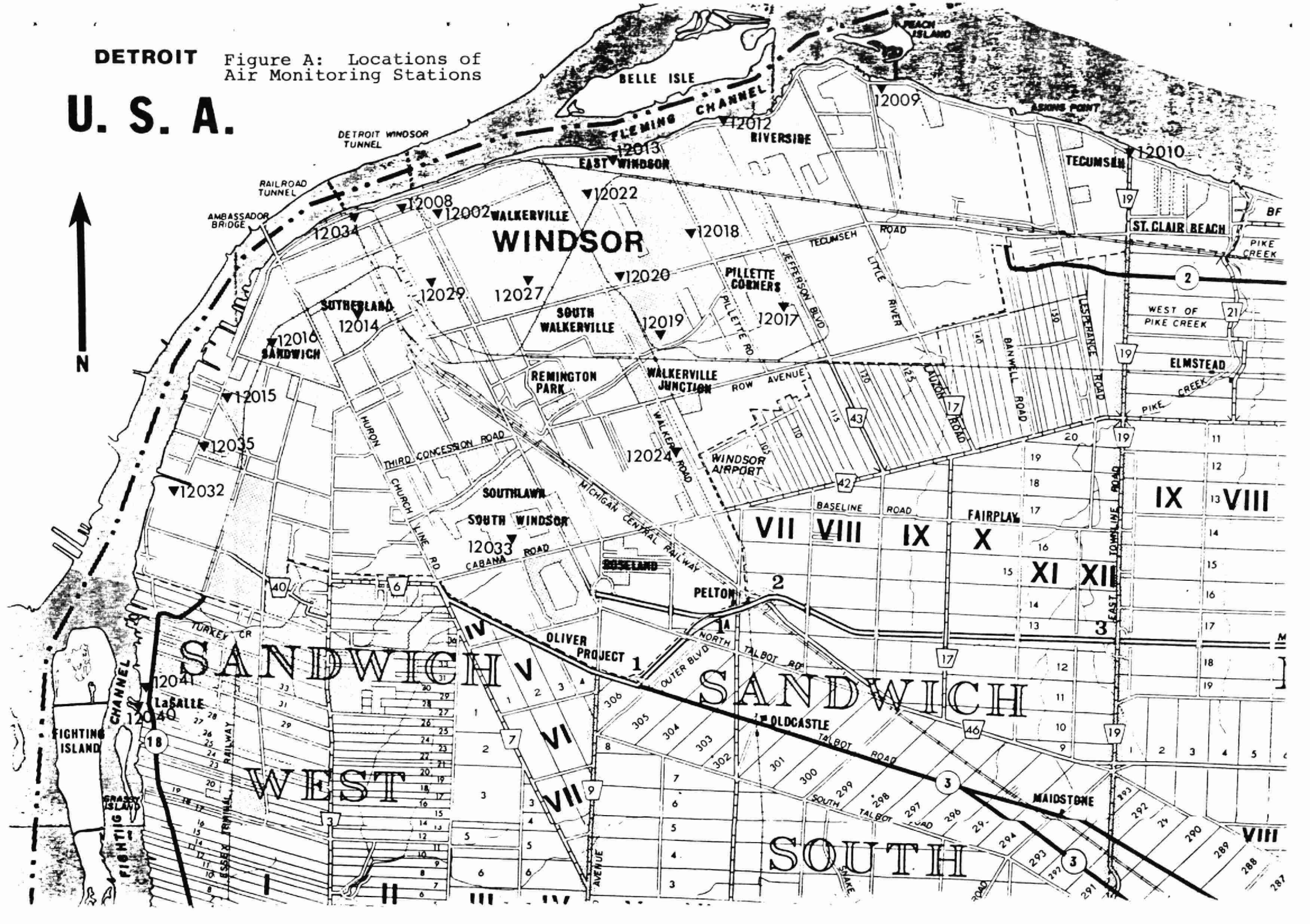


Figure A: Locations of Air Monitoring Stations

Table A - Locations of Air
Monitoring Stations

STATION NUMBER	LOCATION	UNIVERSAL TRANSVERSE MERCATOR PROJECTION CO-ORDINATES	ELEVATION ABOVE SEA LEVEL (FEET)	AIR INTAKE HEIGHT (FEET)
12002	444 Windsor Avenue, City Hall	03323 - 46867	600	50
12008	467 University Avenue	03316 - 46867	600	35
12009	Tecumseh Water Works	03413 - 46888	590	6
12010	Tecumseh Sewage Pumping Station	03460 - 46875	595	4
12012	7007 Riverside Drive East	03385 - 46882	580	12
12013	3665 Wyandotte Street East	03358 - 46874	600	20
12014	College/California Street	03304 - 46849	600	3
12015	Highway No. 18/Prospect	03283 - 46833	575	17
12016	College/South Street	03290 - 46841	600	12
12017	5066 Joinville Street	03388 - 46850	600	15
12018	W. P. Herman Collegiate	03372 - 46858	600	15
12019	Somme/Alexis Street	03369 - 46842	600	15
12020	1869 Albert Street	03363 - 46854	600	15
12022	Hickory/Richmond Street	03352 - 46870	600	15
12024	Byng/Seymore Street	03369 - 46820	600	15
12027	1526 Parent Street	03340 - 46852	600	15
12029	459 Ellis West	03323 - 46853	600	15

continued ....

Table A - Continued

STATION NUMBER	LOCATION	UNIVERSAL TRANSVERSE MERCATOR PROJECTION CO-ORDINATES	ELEVATION ABOVE SEA LEVEL (FEET)	AIR INTAKE HEIGHT (FEET)
12032	Morton Dock	03271 - 46817	575	12
12033	3501 Longfellow	03335 - 46801	600	15
12034	C. P. Telecomunication Tower	03308 - 46868	575	35 & 150
12035	Healy/Sandwich	03276 - 46826	600	15
12040	225 Willow Drive (La Salle)	03261 - 46774	575	15
12041	170 Willow Drive (La Salle)	03263 - 46773	575	15

Table B - Parameters Monitored In The
Ambient Air In Windsor During 1976

STATION NUMBER	AIR POLLUTION INDEX	CARBON MONOXIDE	DUSTFALL	FLUORIDATION RATE	HYDROCARBONS	METEOROLOGICAL DATA	NITRIC OXIDE	NITROGEN DIOXIDE	NITROGEN OXIDES	OZONE	SOILING INDEX (COH)	SULPHATION RATE	SULPHUR DIOXIDE	SUSPENDED PARTICULATES
12002			X								X	X		X
12008	X	X	X	X	X		X	X	X	X	X	X	X	X
12009			X									X		X
12010			X								X	X		X
12012			X									X		X
12013			X								X	X	X	X
12014			X								X	X		X
12015			X	X							X	X	X	X
12016	X		X	X							X	X	X	X
12017												X		
12018												X		
12019			X									X		
12020			X									X		
12022			X	X								X		
12024			X									X		
12027			X	X								X		
12029			X									X		
12032			X	X		X					X	X	X	X
12033			X									X		
12034						X								
12035			X	X								X		
12040			X	X								X		
12041			X									X		

Table C - Desirable Ambient Air Quality
Criteria Established by the Ontario Ministry
of the Environment

PARAMETER	DESIRABLE AMBIENT AIR QUALITY CRITERIA	PRIME REASONS FOR ESTABLISHING CRITERIA OR MONITORING PARAMETER
Carbon Monoxide	30 ppm during 1 hour	Protection of human health.
	13 ppm during 8 hours	Protection of human health.
Dustfall	20 tons/mile^2 in 30 days	Historical and in keeping with other control agencies.
	13 tons/mile^2 (monthly average in 1 year)	
Fluoridation Rate	40 ug of fluorides/100 cm^2 of limed filter paper in 30 days during April 15 to October 15.	Protection of vegetation.
	80 ug of fluorides/100 cm^2 of limed filter paper in 30 days during October 16 to April 14.	Protection of vegetation (less restrictive criterion during the non growing season).
Hydrocarbons (Total)	NONE	Effects of hydrocarbons vary widely depending on their chemical-physical nature.
Nitric Oxide	NONE	Reacts with oxygen to produce NO_2

continued .....

Table C - continued

PARAMETER	DESIRABLE AMBIENT AIR QUALITY CRITERIA	PRIME REASONS FOR ESTABLISHING CRITERIA OR MONITORING PARAMETER
Nitrogen Dioxide	0.20 ppm during 1 hour	Protection of human health and protection against malodours.
	0.10 ppm during 24 hours	Protection of human health and protection against malodours.
Nitrogen Oxides	NONE	
Ozone	0.08 ppm during 1 hour	Protection of vegetation and human health.
Soiling (co-efficient of haze - COH)	1.0 COH per 1000 ft. of air averaged for 24-hours	Based on health effects in combination with SO_2
	0.5 COH per 1000 ft. of air averaged for 1-year	Based on health effects in combination with SO_2
Sulphation Rate	0.7 mg of SO_3 per 100 cm^2 of of lead peroxide per day	Serves to measure relative amount of sulphur oxides over extensive periods of time thus permitting comparisons to annual average concentrations.
Sulphur Dioxide	0.25 ppm during 1 hour	Protection of vegetation
	0.10 ppm during 1 day (24 hours)	Protection of human health
	0.02 ppm during 1 year	Protection of vegetation

continued .....

Table C - continued

PARAMETER	DESIRABLE AMBIENT AIR QUALITY CRITERIA	PRIME REASONS FOR ESTABLISHING CRITERIA OR MONITORING PARAMETER
Suspended Particulates	120 ug/m^3 during 24 hours	Based on impairment of visibility and health effects.
	60 ug/m^3 (geometric mean) during 1 year	Based on public awareness of visible pollution.

A P P E N D I X I I

METEOROLOGICAL DATA

Table D - Percent Frequency of
Wind Direction

STATION NO. 12032 (Morton Dock) - WIND DIRECTION AT 30 METERS

WIND DIRECTION	YEAR				
	1972	1973	1974	1975	1976
North	9.0	13.0	7.3	6.8	9.7
North East	11.2	10.7	10.3	10.6	8.8
East	11.3	11.2	8.5	10.6	8.3
Southeast	8.6	7.8	7.0	8.1	7.2
South	15.9	11.8	22.5	16.6	14.5
South West	15.0	19.2	16.7	19.4	16.2
West	14.7	13.9	14.6	15.6	20.2
North West	14.3	12.3	13.0	12.3	15.1

A P P E N D I X I I I

PARTICULATES

Table E - 1976 Data For Dustfall

In Windsor

(TONS/SQ. MILE/30 DAYS)

STATION NUMBER	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANNUAL AVERAGE
12002	25	37	44	35	38	26	27	22	25	30	26	27	30
12008	15	32	31	25	26	19	20	16	17	17	20	15	21
12009	6	16	18	13	16	11	13	15	12	10	11	9	13
12010	5	10	35	29	15	32	23	18	ND	11	15	12	19
12012	8	17	13	16	19	19	14	11	12	14	12	8	14
12013	20	22	26	29	34	40	24	15	29	38	25	28	28
12014	17	31	32	24	21	40	27	20	25	20	27	28	26
12015	60	38	56	41	36	31	29	19	42	28	27	39	37
12016	26	27	28	24	22	24	23	20	22	16	19	19	23
12017	10	14	16	18	14	15	13	9	18	14	12	10	14
12019	5	15	19	21	18	17	16	14	15	20	12	9	15
12020	11	20	30	22	26	25	29	17	18	15	16	14	20
12022	15	27	43	36	42	33	37	25	30	27	22	17	30
12024	5	21	16	18	20	27	14	11	ND	17	13	ND	16
12027	21	31	45	28	27	19	25	18	22	22	19	18	25
12029	12	22	24	22	22	16	15	18	18	15	14	10	17
12032	18	22	23	25	25	32	20	27	20	20	19	23	23
12033	9	18	15	20	18	26	38	12	15	13	18	8	18
12035	28	32	33	36	40	ND	14	62	44	27	19	19	32
12040	9	16	20	26	28	29	18	17	26	30	14	9	20
12041	13	16	ND	20	21	23	25	17	17	15	10	9	17

ND: NO DATA

Table F - Summary of Dustfall Levels
In Windsor From 1972 to 1976

(TONS/SQ. MILE/30 DAYS)

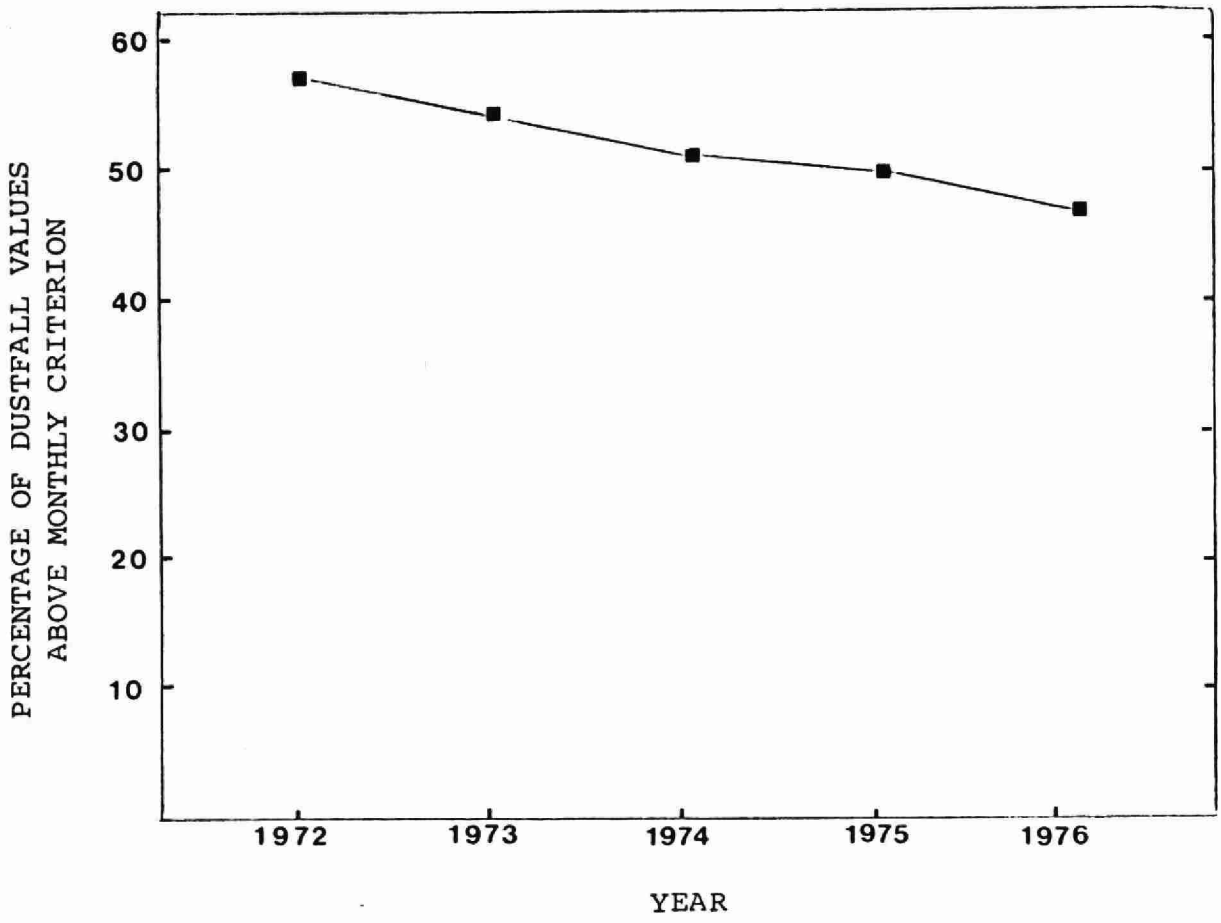
	1972		1973		1974		1975		1976	
STATION NUMBER	ANNUAL AVERAGE	PERCENTAGE OF VALUES ABOVE MONTHLY CRITERION	ANNUAL AVERAGE	PERCENTAGE OF VALUES ABOVE MONTHLY CRITERION	ANNUAL AVERAGE	PERCENTAGE OF VALUES ABOVE MONTHLY CRITERION	ANNUAL AVERAGE	PERCENTAGE OF VALUES ABOVE MONTHLY CRITERION	ANNUAL AVERAGE	PERCENTAGE OF VALUES ABOVE MONTHLY CRITERION
12002	34	100	28	100	32	100	28	83	30	100
12008	23	50	24	75	32	82	23	58	21	33
12009	13	0	12	0	12	0	15	17	13	0
12010	17	33	24	50	29	36	16	11	19	36
12012	14	8	14	9	18	33	17	17	14	0
12013	29	92	30	75	30	75	25	83	28	83
12014	30	100	27	100	30	91	25	58	26	75
12015	44	100	31	100	43	100	36	100	37	92
12016	N O T	I N	O P E R A T I O N				26	50	23	67
12017	13	17	11	0	11	9	19	38	14	0
12019	17	33	18	27	16	25	18	33	15	8
12020	20	33	21	50	19	33	18	17	20	42
12022	33	100	35	92	31	92	32	92	30	83
12024	17	17	15	17	16	8	16	27	16	20
12027	39	91	27	92	30	75	27	75	25	67

continued .....

Table F - continued ....

STATION NUMBER	1972 ANNUAL AVERAGE	1972 PERCENTAGE OF VALUES ABOVE MONTHLY CRITERION	1973 ANNUAL AVERAGE	1973 PERCENTAGE OF VALUES ABOVE MONTHLY CRITERION	1974 ANNUAL AVERAGE	1974 PERCENTAGE OF VALUES ABOVE MONTHLY CRITERION	1975 ANNUAL AVERAGE	1975 PERCENTAGE OF VALUES ABOVE MONTHLY CRITERION	1976 ANNUAL AVERAGE	1976 PERCENTAGE OF VALUES ABOVE MONTHLY CRITERION
12029	25	75	20	42	19	27	19	17	17	33
12032	23	50	26	73	21	50	28	50	23	58
12033	16	18	13	0	14	17	14	8	18	17
12035	36	100	34	92	33	100	36	100	32	73
12040	24	58	23	50	20	50	23	50	20	42
12041	28	58	17	25	17	17	19	25	17	27
AVERAGES FOR STATIONS	25	57	23	54	24	51	23	49	22	46

Figure B - Trend In Dustfall Levels
Based On Data From Twenty Monitoring Stations In Windsor



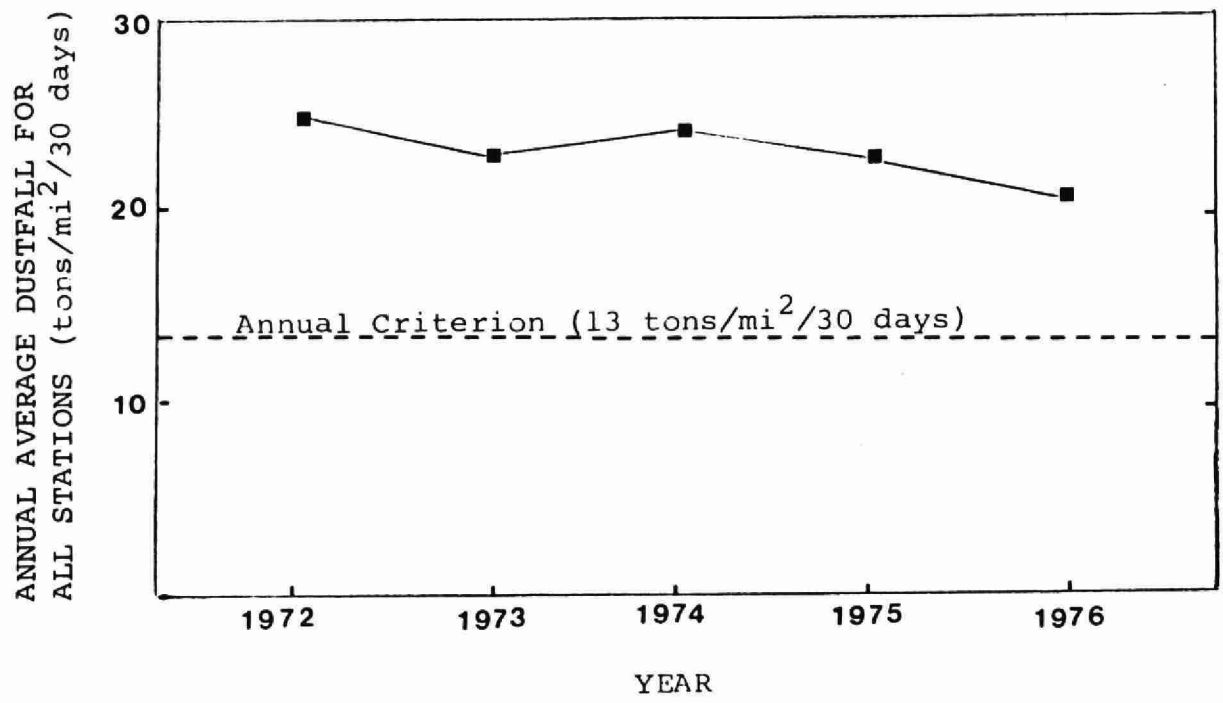
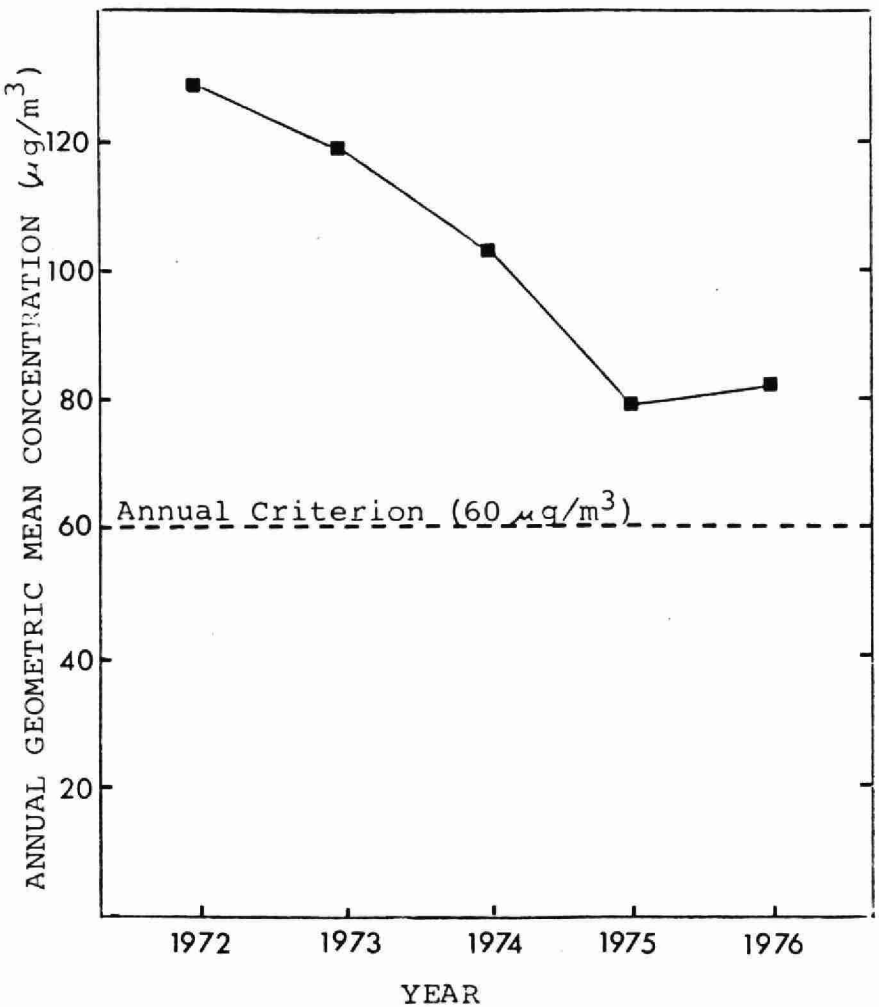


Table G - Summary Of Suspended Particulate Levels In Windsor From 1972 to 1976

STATION NUMBER	1972 ANNUAL GEOMETRIC MEAN ug/m^3	1972 PERCENTAGE OF VALUES GREATER THAN 24-HOUR CRITERION	1973 ANNUAL GEOMETRIC MEAN ug/m^3	1973 PERCENTAGE OF VALUES GREATER THAN 24-HOUR CRITERION	1974 ANNUAL GEOMETRIC MEAN ug/m^3	1974 PERCENTAGE OF VALUES GREATER THAN 24-HOUR CRITERION	1975 ANNUAL GEOMETRIC MEAN ug/m^3	1975 PERCENTAGE OF VALUES GREATER THAN 24-HOUR CRITERION	1976 ANNUAL GEOMETRIC MEAN ug/m^3	1976 PERCENTAGE OF VALUES GREATER THAN 24-HOUR CRITERION
12002	159	70	133	58	108	43	74	14	78	17
12008	126	57	126	55	116	47	82	17	80	19
12009	79	16	82	25	61	10	52	2	58	5
12010	85	23	86	27	58	17	46	2	54	10
12012	100	43	87	36	84	27	79	17	65	11
12013	151	65	145	69	113	44	89	26	98	37
12014	152	70	148	72	139	64	95	25	95	26
12015	183	80	147	66	152	84	105	33	113	42
12016	NO DATA AVAILABLE						88	20	90	25
12032	126	53	120	53	94	30	81	21	89	27
AVERAGES FOR STATIONS	129	53	119	51	102	41	79	18	82	22

Figure C - Trend In Suspended Particulate Levels
Based On Data From Ten Monitoring Stations In Windsor
1972 - 1976



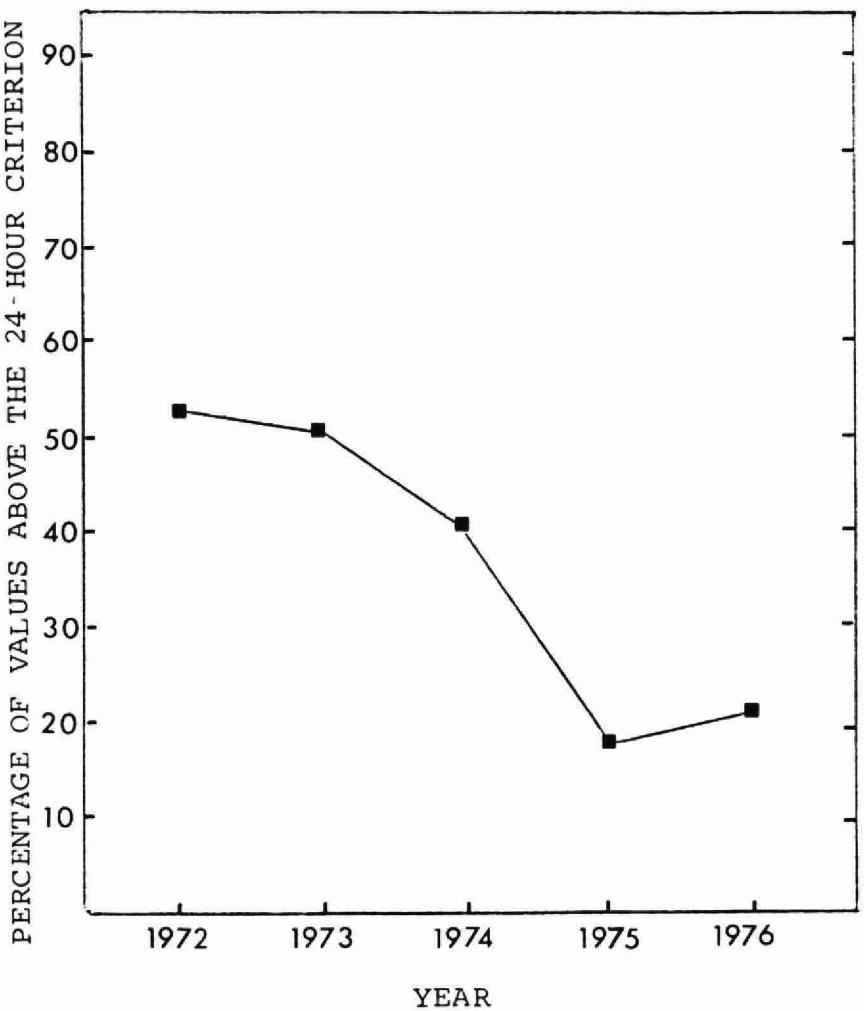
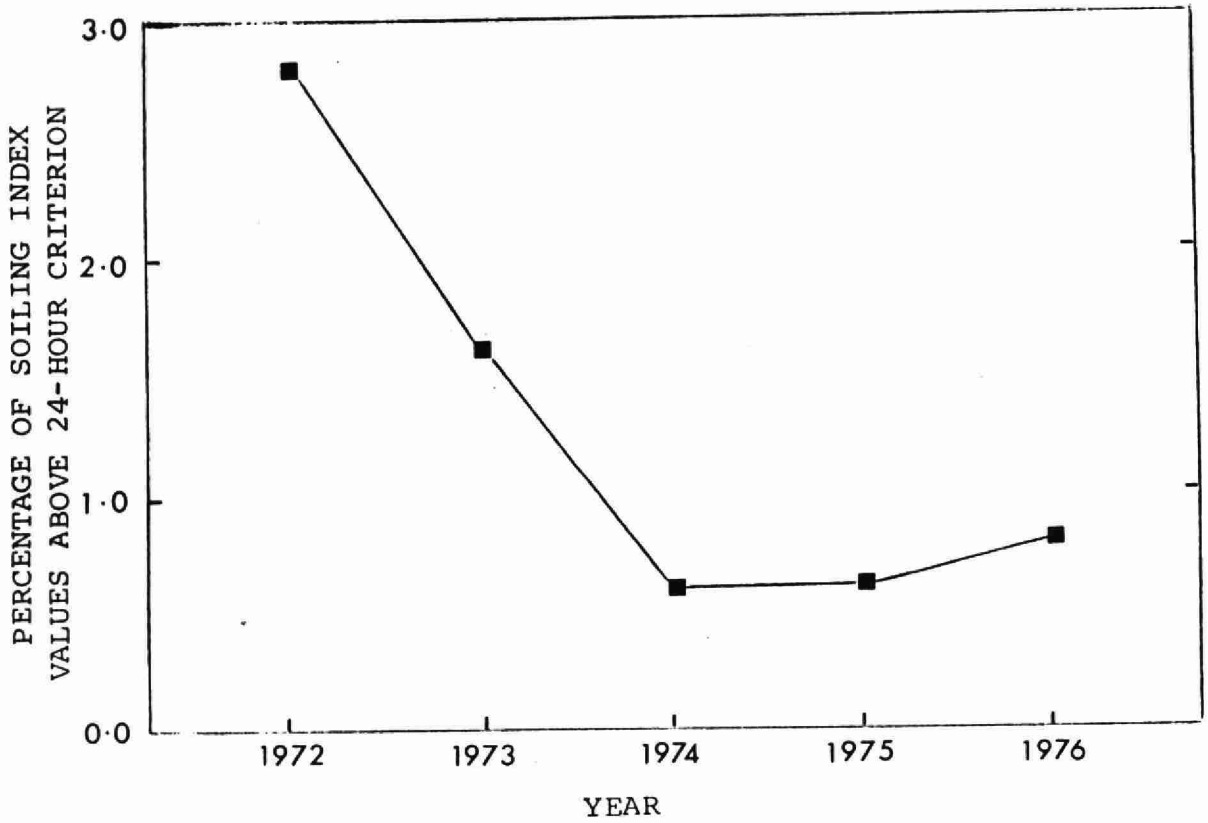
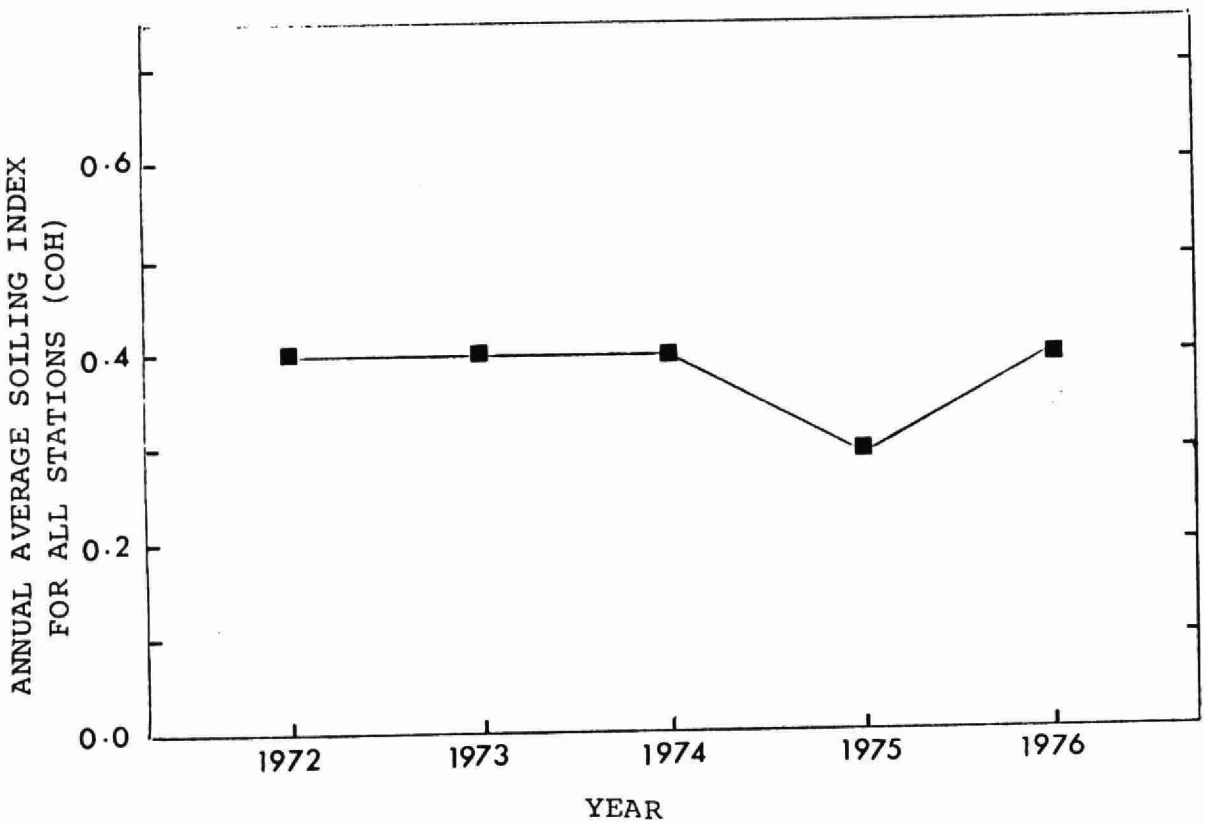


Table H - Summary Of Soiling Index Levels (COH)
In Windsor From 1972 to 1976

STATION NUMBER	1972 ANNUAL AVERAGE	1972 PERCENTAGE OF VALUES ABOVE 24-HOUR CRITERION	1973 ANNUAL AVERAGE	1973 PERCENTAGE OF VALUES ABOVE 24-HOUR CRITERION	1974 ANNUAL AVERAGE	1974 PERCENTAGE OF VALUES ABOVE 24-HOUR CRITERION	1975 ANNUAL AVERAGE	1975 PERCENTAGE OF VALUES ABOVE 24-HOUR CRITERION	1976 ANNUAL AVERAGE	1976 PERCENTAGE OF VALUES ABOVE 24-HOUR CRITERION
12002	INSUFFICIENT DATA		0.4	2.7	0.4	0.3	0.2	0.3	0.3	0.0
12008	0.5	3.3	0.5	2.5	0.4	2.0	0.4	1.4	0.5	1.7
12010	INSUFFICIENT DATA		0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0
12013	NO DATA		NO DATA		0.4	0.6	0.3	0.8	0.4	1.2
12014	0.3	1.3	0.4	0.7	0.4	0.9	0.3	0.6	0.3	0.7
12015	0.5	6.6	0.5	3.2	0.4	0.3	0.4	0.7	0.4	1.2
12016	NO DATA		NO DATA		NO DATA		0.4	0.6	0.5	1.4
12032	0.4	0.0	0.3	0.3	0.3	0.0	0.2	0.0	0.3	0.0
AVERAGE FOR STATIONS	0.4	2.8	0.4	1.6	0.4	0.6	0.3	0.6	0.4	0.8

Figure D - Trend In Soiling Index Based On
Data From Eight Monitoring Stations In Windsor





A P P E N D I X I V

SULPHUR OXIDES

Table I - Concentrations Of Sulphur Dioxide Greater Than The 1-Hour And 24-Hour Criteria During 1976

TIME (1976)	STATION 12008 (ppm)		STATION 12015 (ppm)		STATION 12016 (ppm)		STATION 12032 (ppm)	
	1-HOUR CONCENTRATION	24-HOUR CONCENTRATION	1-HOUR CONCENTRATION	24-HOUR CONCENTRATION	1-HOUR CONCENTRATION	24-HOUR CONCENTRATION	1-HOUR CONCENTRATION	24-HOUR CONCENTRATION
January 5		0.11						
January 8			0.53					
1600-1700 HRS			0.53					
1700-1800 HRS			0.51					
1900-2000 HRS			0.29					
2100-2200 HRS			0.33					
January 9						.12		
0900-1000 HRS					0.31			
1600-1700 HRS					0.30			
1700-1800 HRS					0.28			
1800-1900 HRS					0.30			
January 19								
2100-2200 HRS					0.28			
January 20				0.20				
1000-1100 HRS			0.90					
1100-1200 HRS			0.58					
1200-1300 HRS			0.71					
1300-1400 HRS			0.37					
1400-1500 HRS			0.63					
1500-1600 HRS			0.62					
1600-1700 HRS			0.44					

continued .....

Table 1 - continued ....

TIME (1976)	STATION 12008 (ppm)		STATION 12015 (ppm)		STATION 12016 (ppm)		STATION 12032 (ppm)	
	1-HOUR CONCENTRATION	24-HOUR CONCENTRATION	1-HOUR CONCENTRATION	24-HOUR CONCENTRATION	1-HOUR CONCENTRATION	24-HOUR CONCENTRATION	1-HOUR CONCENTRATION	24-HOUR CONCENTRATION
February 2				0.11				
1200-1300 HRS			0.41					
1300-1400 HRS			0.48					
1400-1500 HRS			0.31					
1500-1600 HRS			0.44					
1700-1800 HRS			0.28					
1900-2000 HRS					0.33			
February 3								
0900-1000 HRS	0.31							
February 4								
0100-0200 HRS	0.28							
February 13								
0600-0700 HRS	0.28							
0700-0800 HRS	0.26							
February 29								
1000-1100 HRS	0.30							
September 28								
0000-0100 HRS							0.27	
0500-0600 HRS							0.43	

Table 1 - Summary of Sulphur Dioxide Levels
In Windsor From 1972 to 1976

STATION NUMBER	1972 ANNUAL AVERAGE (ppm)	1972 PERCENTAGE OF VALUES GREATER THAN CRITERIA 1-HOUR	1972 PERCENTAGE OF VALUES GREATER THAN CRITERIA 24-HOUR	1973 ANNUAL AVERAGE (ppm)	1973 PERCENTAGE OF VALUES GREATER THAN CRITERIA 1-HOUR	1973 PERCENTAGE OF VALUES GREATER THAN CRITERIA 24-HOUR	1974 ANNUAL AVERAGE (ppm)	1974 PERCENTAGE OF VALUES GREATER THAN CRITERIA 1-HOUR	1974 PERCENTAGE OF VALUES GREATER THAN CRITERIA 24-HOUR	1975 ANNUAL AVERAGE (ppm)	1975 PERCENTAGE OF VALUES GREATER THAN CRITERIA 1-HOUR	1975 PERCENTAGE OF VALUES GREATER THAN CRITERIA 24-HOUR	1976 ANNUAL AVERAGE (ppm)	1976 PERCENTAGE OF VALUES GREATER THAN CRITERIA 1-HOUR	1976 PERCENTAGE OF VALUES GREATER THAN CRITERIA 24-HOUR
12008	0.04	0.73	3.6	0.03	0.36	2.2	0.03	0.25	1.7	0.03	0.03	0.6	0.03	0.06	0.3
12015	N O	D A T A		N O	D A T A		0.02	0.64	1.3	0.01	0.23	0.6	0.02	0.20	0.6
12016	N O	D A T A		N O	D A T A		N O	D A T A		0.02	0.05	0.0	0.02	0.07	0.3
12032	0.03	0.06	0.0	0.02	0.47	1.6	0.02	0.11	0.0	INSUFFICIENT	DATA		0.02	0.03	0.0

Table K - 1976 Data For Sulphation Rate
In Windsor

(mg/100 cm^2/day)

STATION NUMBER	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANNUAL AVERAGE
12002	0.54	ND	0.24	0.46	0.24	0.42	0.32	0.43	INV	0.48	0.46	0.52	0.41
12008	0.91	1.12	1.10	0.34	0.18	0.26	0.22	0.25	0.27	0.28	0.28	INV	0.47
12009	0.28	0.18	0.34	0.36	0.34	0.20	0.22	0.40	0.48	0.54	0.51	0.71	0.38
12010	0.12	0.14	0.10	0.05	0.24	0.26	0.12	0.17	0.26	ND	0.20	0.36	0.18
12012	0.48	0.27	ND	0.50	0.26	0.32	0.30	0.33	0.41	INV	0.32	0.79	0.40
12013	ND	0.21	0.18	0.46	0.24	0.40	0.30	0.45	0.41	INV	0.40	0.65	0.37
12014	0.83	0.38	0.30	0.74	0.54	0.56	INV	0.60	0.52	INV	0.64	0.72	0.58
12015	ND	0.85	0.26	1.40	2.02	ND	0.90	0.83	0.87	1.14	0.92	1.14	1.03
12016	ND	0.79	1.16	1.18	1.90	0.82	0.70	0.85	0.73	INV	0.82	1.04	1.00
12017	ND	0.42	0.34	0.52	1.22	0.32	0.30	0.40	0.40	INV	0.41	0.83	0.52
12018	0.53	0.42	0.40	0.60	0.42	0.32	0.22	0.40	0.40	0.50	0.42	0.55	0.43
12019	0.55	0.36	ND	0.52	0.34	0.26	0.26	0.30	0.36	0.62	0.41	0.68	0.42
12020	0.46	ND	0.42	0.58	0.34	0.34	0.30	0.37	0.38	INV	0.36	0.49	0.40
12022	ND	0.42	0.40	0.44	0.44	0.44	0.34	0.47	0.44	0.50	0.46	0.49	0.44
12024	0.42	0.36	0.26	0.32	0.42	0.18	0.30	0.22	0.25	INV	0.32	0.49	0.32

continued .....

Table K - continued ....

STATION NUMBER	JAN.	FEB.	MAR.	APRIL.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANNUAL AVERAGE
12027	0.52	0.43	ND	0.44	0.44	0.48	0.42	0.40	0.41	INV	0.46	0.68	0.47
12029	0.82	ND	0.54	0.70	0.38	0.48	0.54	0.47	0.46	INV	0.40	0.79	0.56
12032	0.85	0.42	0.48	0.76	0.28	0.48	0.54	0.51	0.56	0.66	0.50	0.78	0.57
12033	0.46	0.43	ND	0.40	0.46	0.36	0.20	0.45	0.40	INV	0.42	0.59	0.42
12035	ND	0.57	0.94	0.76	0.68	ND	0.58	0.63	INV	0.78	0.56	1.10	0.73
12040	0.64	0.36	ND	0.36	0.46	0.32	0.22	0.37	0.37	0.48	0.36	0.64	0.42
12041	0.60	0.40	0.44	0.44	0.40	0.32	0.30	0.33	0.34	0.42	0.32	0.78	0.42

ND: NO DATA

INV: INVALID

DATA UNDERLINED ARE ABOVE CRITERION

Table L - Summary Of Sulphation Rate Levels
In Windsor From 1972 to 1976

(mg SO_3/100 cm^2/day)

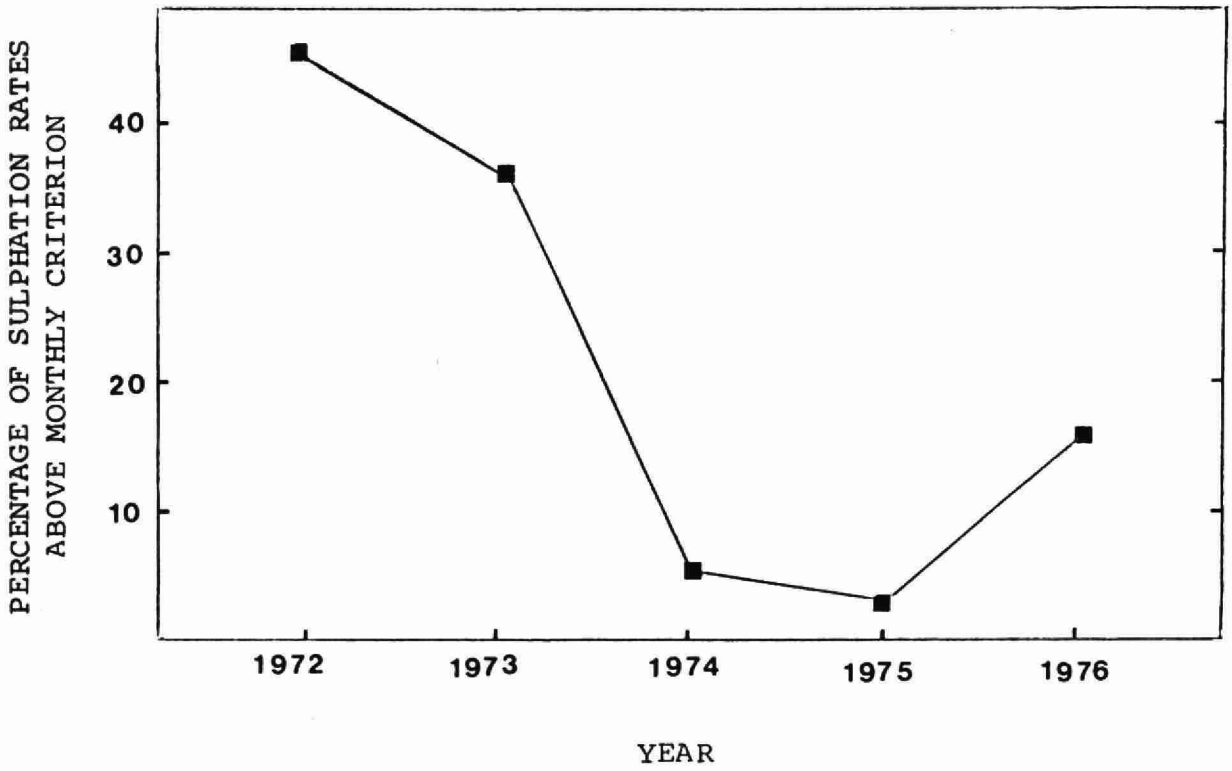
	1972		1973		1974		1975		1976	
STATION NUMBER	ANNUAL AVERAGE	PERCENTAGE OF VALUES ABOVE CRITERION	ANNUAL AVERAGE	PERCENTAGE OF VALUES ABOVE CRITERION	ANNUAL AVERAGE	PERCENTAGE OF VALUES ABOVE CRITERION	ANNUAL AVERAGE	PERCENTAGE OF VALUES ABOVE CRITERION	ANNUAL AVERAGE	PERCENTAGE OF VALUES ABOVE CRITERION
12002	0.76	42	0.59	36	0.30	0	0.28	0	0.41	0
12008	1.47	82	1.11	50	0.68	42	0.47	18	0.47	27
12009	0.65	33	0.59	33	0.25	0	0.24	0	0.38	8
12010	0.34	0	0.32	17	0.13	0	0.14	0	0.18	0
12012	0.70	42	0.68	42	0.28	0	0.22	0	0.40	10
12013	0.64	42	0.56	9	0.26	0	0.25	0	0.37	0
12014	1.10	67	0.99	92	0.47	8	0.35	0	0.58	30
12015	2.06	100	1.91	100	0.85	50	0.57	18	1.03	90
12016	N O T	I N	O P E R A T I O N				0.50	14	1.00	90
12017	0.58	36	0.53	25	0.30	0	0.23	0	0.52	20
12018	0.62	42	0.42	20	0.25	0	0.24	0	0.43	0
12019	0.68	44	0.60	17	0.25	0	0.24	0	0.42	0
12020	0.58	42	0.51	8	0.24	0	0.24	0	0.40	0
12022	0.63	42	0.62	42	0.29	0	0.26	0	0.44	0
12024	0.43	25	0.38	8	0.20	0	0.18	0	0.32	0
12027	0.66	42	0.59	17	0.26	0	0.23	0	0.47	0

continued .....

Table L - continued ....

STATION NUMBER	1972 ANNUAL AVERAGE	1972 PERCENTAGE OF VALUES ABOVE CRITERION	1973 ANNUAL AVERAGE	1973 PERCENTAGE OF VALUES ABOVE CRITERION	1974 ANNUAL AVERAGE	1974 PERCENTAGE OF VALUES ABOVE CRITERION	1975 ANNUAL AVERAGE	1975 PERCENTAGE OF VALUES ABOVE CRITERION	1976 ANNUAL AVERAGE	1976 PERCENTAGE OF VALUES ABOVE CRITERION
12029	0.87	42	0.88	64	0.39	0	0.34	0	0.56	20
12032	0.90	67	0.78	58	0.38	0	0.32	0	0.57	25
12033	0.66	36	0.55	25	0.28	0	0.27	0	0.42	0
12035	1.15	82	1.01	64	0.54	27	0.42	9	0.73	44
12040	0.61	33	0.49	8	0.25	0	0.24	0	0.42	0
12041	0.56	27	0.44	17	0.23	0	0.23	0	0.42	8
AVERAGES FOR STATIONS	0.79	45	0.69	36	0.34	6	0.28	3	0.50	16

Figure E - Trend In Sulphation Rate Levels
Based On Data From Twenty-Two
Monitoring Stations In Windsor



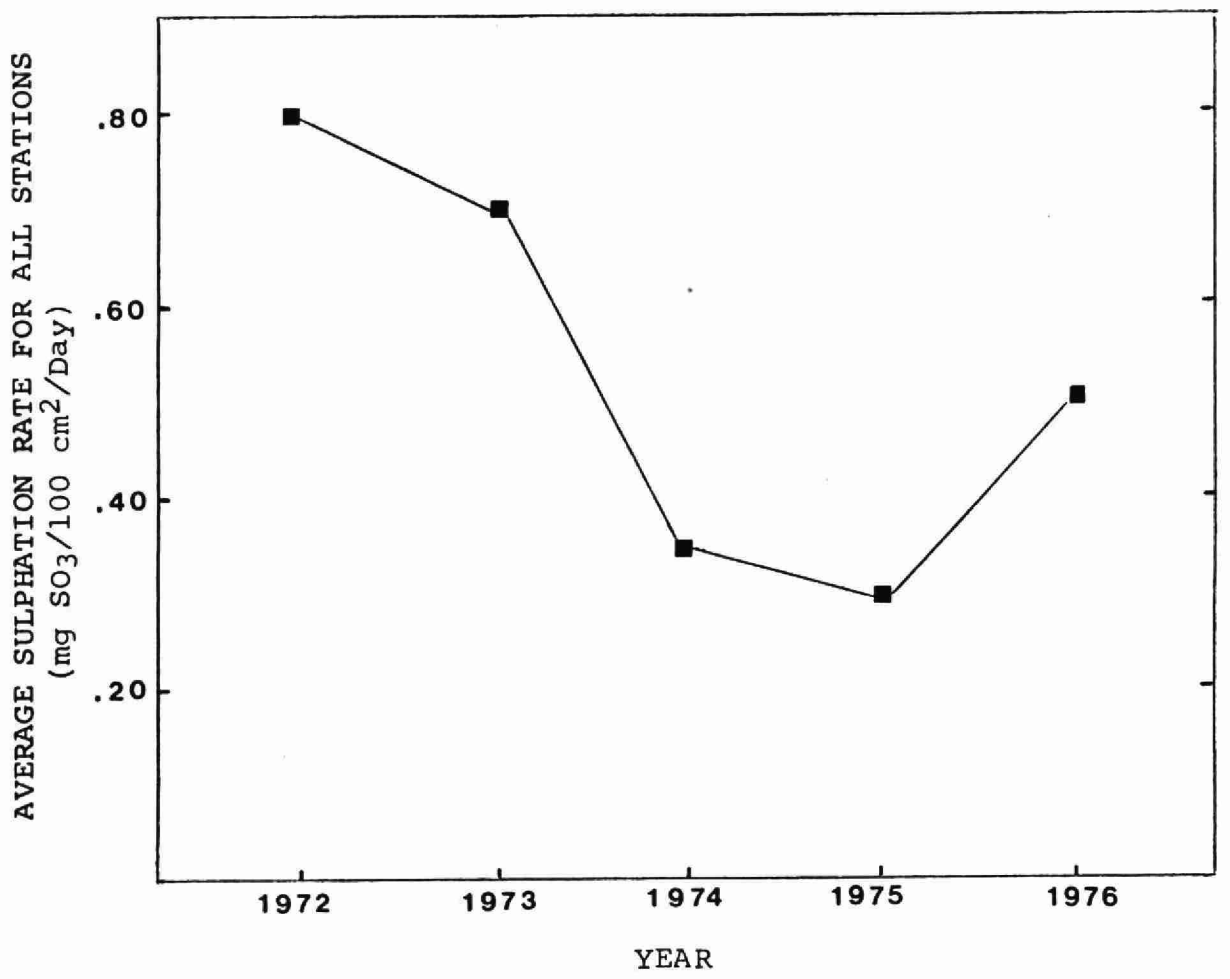


Table M - Summary of the Sulphate Content in Suspended Particulates

STATION NUMBER	ANNUAL AVERAGE SULPHATE CONCENTRATION (ug/m^3)	ANNUAL AVERAGE SUSPENDED PARTICULATE CONCENTRATION (ug/m^3)	ANNUAL AVERAGE PERCENTAGE OF SULPHATES IN SUSPENDED PARTICULATES
12002	9.4	87	11
12008	10.2	89	11
12010	6.9	63	11
12013	8.1	117	7
12032	10.6	100	11

APPENDIX V

CARBON MONOXIDE

NITROGEN OXIDES

HYDROCARBONS

OXIDANT DATA

Table N - Summary Of Data For Carbon Monoxide, Nitrogen Oxides, Hydrocarbons, And Oxidants Measured At Station 12008 (Downtown Windsor)

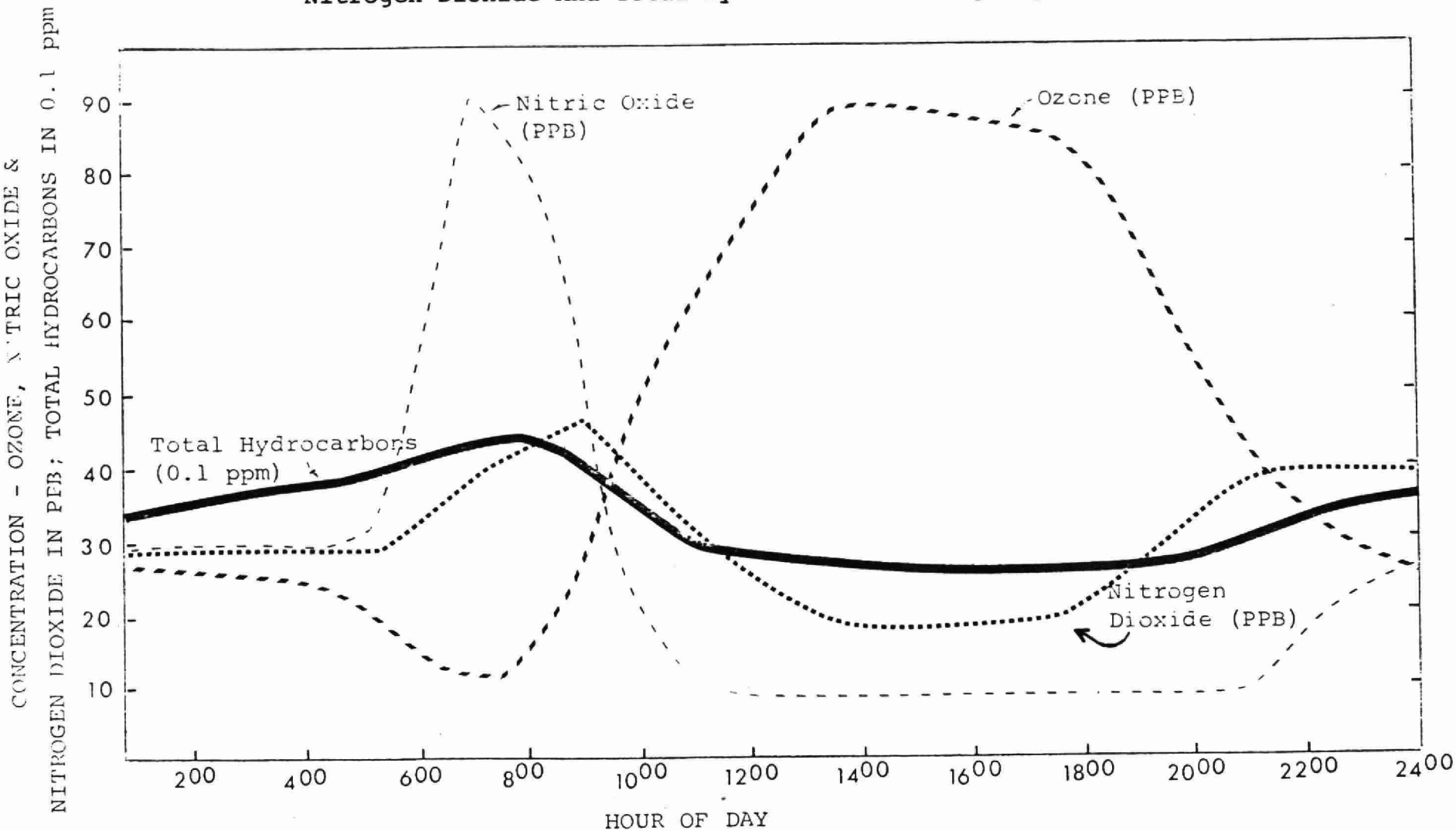
POLLUTANT	YEAR	ANNUAL AVERAGE (ppm)	PERCENTAGE OF RESULTS GREATER THAN INDICATED CRITERION	
			1-Hour Criterion: 30 ppm	8-Hour Criterion: 13 ppm
Carbon Monoxide	1972	5	0	0
	1973	5	0.01	0
	1974	5	0	0.20
	1975	5	0	0.21
	1976	4	0	0
			N O C R I T E R I A	
Total Hydrocarbons	1972	2.2		
	1973	2.1		
	1974	1.9		
	1975	2.2		
	1976	2.6		
			N O C R I T E R I A	
Nitric Oxide	1974	0.04		
	1975	INSUFFICIENT DATA		
	1976	0.03		

CONTINUED ....

Table N - continued ....

POLLUTANT	YEAR	ANNUAL AVERAGE (ppm)	PERCENTAGE OF RESULTS GREATER THAN INDICATED CRITERION	
			1-Hour Criterion: 0.02 ppm	24-Hour Criterion: 0.01 ppm
Nitrogen Dioxide	1972	INSUFFICIENT DATA	0	0
	1973	0.03	0	0
	1974	0.03	0	0
	1975	0.03	0	0
	1976	0.03	0	0
			N O C R I T E R I A	
Nitrogen Oxides	1972	0.02		
	1973	NO DATA		
	1974	0.07		
	1975	0.05		
	1976	0.06		
			1-Hour Criterion: 0.10 ppm	
Total Oxidants	1972	0.02	0.10	
	1973	0.02	0.03	
			1-Hour Criterion: 0.080 ppm	
Ozone	1974	0.014	0.8	
	1975	0.017	2.2	
	1976	0.029	8.1	

Figure F - Average Concentration Cycle For Ozone, Nitric Oxide, Nitrogen Dioxide And Total Hydrocarbons During August, 1976



A P P E N D I X V I

FLUORIDATION RATE

Table 0 - 1976 Data For Fluoridation Rate In Windsor

(ugF/100 cm /30 days)

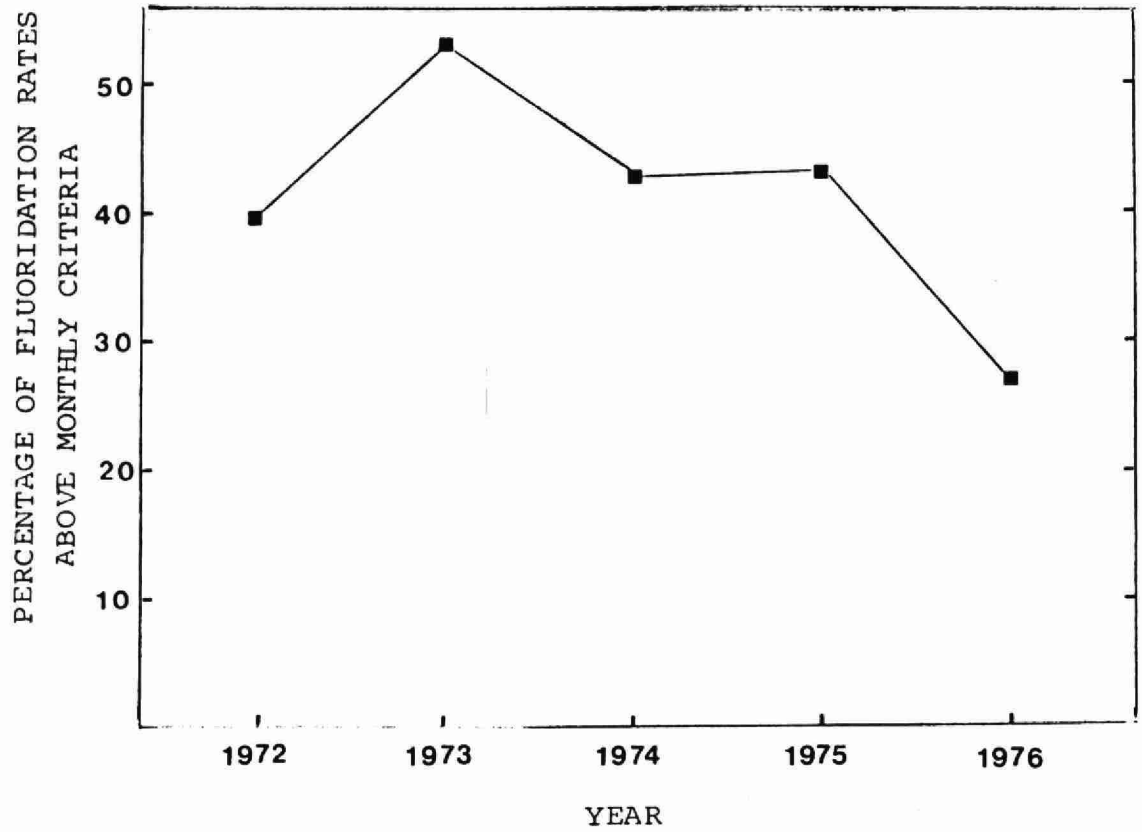
STATION NUMBER	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	AVERAGE
12008	40	39	42	47	26	21	8	51	27	16	36	38	33
12015	51	71	65	45	72	36	34	68	76	33	71	47	56
12016	62	61	58	58	54	21	23	62	43	36	51	39	47
12022	40	31	25	33	32	26	23	65	32	19	30	15	31
12027	33	18	25	25	22	20	14	39	22	19	37	16	24
12032	101	ND	110	116	61	88	52	115	66	94	153	127	98
12035	56	74	56	52	48	56	44	69	49	43	101	59	59
12040	52	46	50	31	21	18	16	61	25	25	27	16	32
AVG/MONTH	54	49	54	51	42	36	27	66	43	36	63	45	48

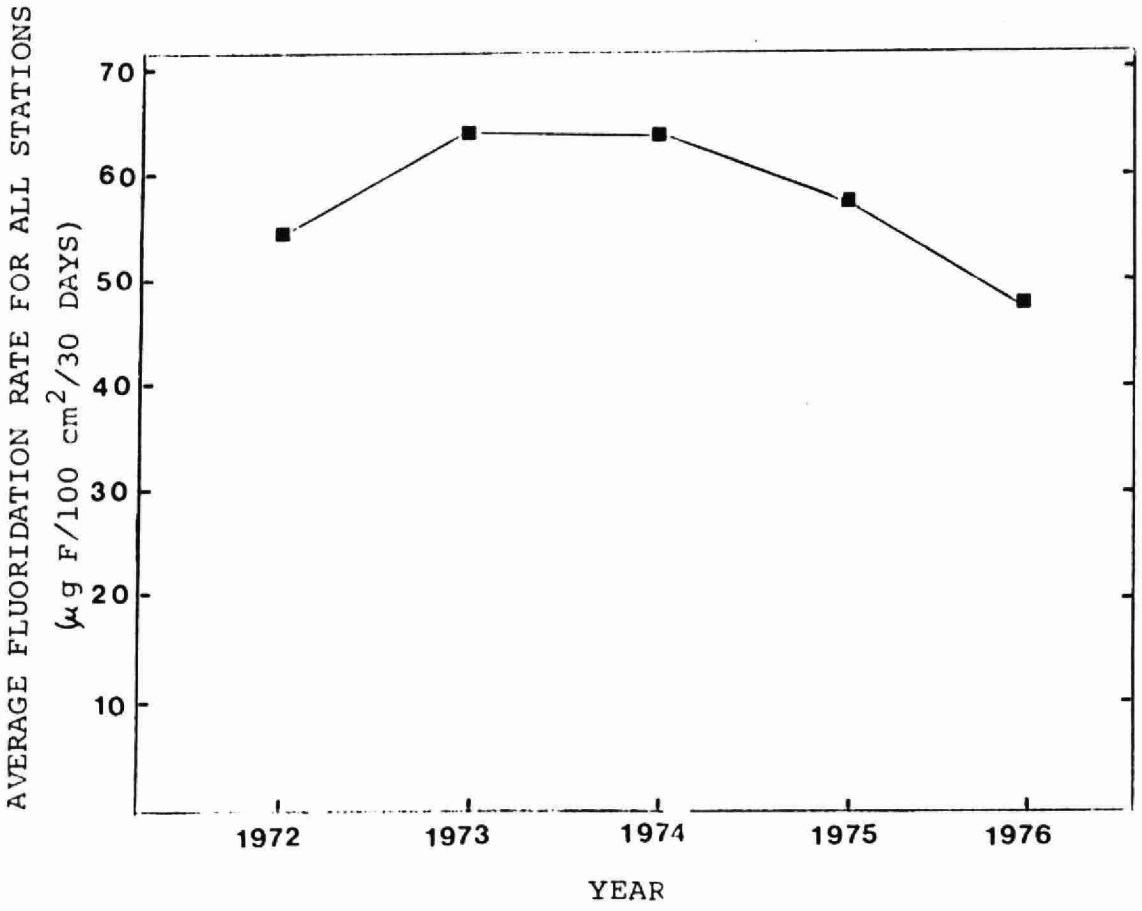
NOTE: 1) ND: NO DATA
2) UNDERLINED DATA ARE ABOVE CRITERIA

Table P - Summary Of Fluoridation Rate Levels
In Windsor From 1972 to 1976

STATION NUMBER	1972 ANNUAL AVERAGE	1972 PERCENTAGE OF VALUES ABOVE CRITERIA	1973 ANNUAL AVERAGE	1973 PERCENTAGE OF VALUES ABOVE CRITERIA	1974 ANNUAL AVERAGE	1974 PERCENTAGE OF VALUES ABOVE CRITERIA	1975 ANNUAL AVERAGE	1975 PERCENTAGE OF VALUES ABOVE CRITERIA	1976 ANNUAL AVERAGE	1976 PERCENTAGE OF VALUES ABOVE CRITERIA
12008	43	18	49	42	47	17	44	42	33	8
12015	79	75	75	75	73	75	66	50	56	25
12016	N O T	I N	O P E R A T I O N				60	56	47	25
12022	44	25	51	33	47	33	40	42	31	8
12027	38	8	41	25	42	8	27	8	24	0
12032	65	50	87	83	105	75	103	75	98	100
12035	71	75	92	75	92	67	87	67	59	50
12040	40	17	51	33	41	17	33	8	32	8
AVERAGE FOR STATIONS	54	39	64	52	64	42	58	43	48	27

Figure G - Trend in Fluoridation Rate Levels
Based On Data From Eight Monitoring Stations In Windsor





DATE	ISSUED TO